

Section II. (Remarks)

The claims pending in the application are 38-60, 62 and 64-69.

Newly Added Claims 65-69

Claims 65-69 have been added herein to encompass specific aspects of the invention.

In such claims, the applicants have taken care to avoid the introduction of new matter and have used language found in the specification, in accordance with MPEP 608.01(o). Support for the subject matter and terminology of these added claims is as follows:

For new claim 65, support for the temperature range of “from about 400°C to about 1200°C” and the pressure range of “from about 0.1 to about 760 torr” can be found on page 16, lines 18-19 in the specification of the originally filed application. Support for the liquid precursor solution A/B ratio range of “from about 0.52 to about 1.52” can be found in FIG. 2 of the originally filed application.

For new claim 66, support for the ferroelectric polarization being “greater than 20 $\mu\text{C}/\text{cm}^2$ ” can be found on page 18 on the fourth line of Table A in the specification of the originally filed application.

For new claim 67, support for the leakage current density being “less than 10^{-4} A/cm²” can be found on the top of page 23 in Table B in the specification of the originally filed application.

For new claim 68, support for the atomic percent lead being “in the range of from about 49.43% to about 55%” can be found on page 33 in the second line of Table 3 and in FIG 2 of the originally filed application.

For new claim 69, support can be found in the definition of “plateau effect determination” at page 6, lines 13-20 of the application as originally filed.

Amendment of Claims 38, 56, 59, 60, 62 and 64

Claims 38, 56, 59, 60, 62 and 64 have been amended herein to advance the application to allowance.

Claim 38 has been amended to recite:

38. (Currently amended) A method of fabricating a ferroelectric PZT film on a substrate, comprising selecting MOCVD conditions for producing a ferroelectric PZT material, and forming the film by liquid delivery MOCVD on the substrate under said MOCVD conditions for producing a said ferroelectric PZT material, wherein said selecting MOCVD conditions comprises:

establishing a correlative empirical matrix of plots of each of ferroelectric polarization, leakage current density, and atomic percent lead in PZT films, as a function of each of temperature, pressure and liquid precursor solution A/B ratio, wherein A/B ratio is the ratio of Pb to (Zr + Ti);

identifying from said plots an inflection point of each plot as defining a region of operation with respect to independent process variables of temperature, pressure and liquid precursor solution A/B ratio; and

conducting the liquid delivery MOCVD at temperature, pressure and liquid precursor solution A/B ratio values selected from said region of operation.

Such amendment is consistent with and supported by the text of the instant application at page 6, lines 13-20 thereof, describing the plateau effect determination methodology of the invention as involving

“...establishing a correlative empirical matrix of plots of each of ferroelectric polarization, leakage current density and atomic percent lead in PZT films, as a function of each of temperature, pressure and liquid precursor solution A/B ratio, wherein A/B ratio is the ratio of Pb to (Zr + Ti), and identifying from the plots the ‘knee’ or inflection point of each plot as defining a region of operation with respect to the independent process variables of temperature, pressure and liquid precursor solution A/B ratio, and conducting the MOCVD process at a corresponding value of the temperature, pressure and liquid precursor solution A/B ratio selected from such region of operation...”

(see specification, page 6, lines 13-20, emphasis added).

Claims 56 and 60 also have been correspondingly amended.

Claims 59, 62 and 64 have been amended to overcome the Examiner's objection to such claims, as well as the rejection of claims 59 and 64 under 35 USC §112, second paragraph.

In the December 1, 2004 Office Action, the Examiner stated:

“The units in claim 62 are unclear. For examination purposes, it is assumed to be micrometers, as is consistent with the specification. Similar problems exist in claims 59 and 64 for the ‘proportional’ sign.”

(Office Action, page 2, lines 4-6)

In response, the applicants have amended claim 62 to include the units as requested by the Examiner, and in claims 59 and 64, the applicants have deleted the “proportional” sign so that the claims now correspond to the text of the specification at the top of page 7 in the application.

In the December 1, 2003 Office Action, the Examiner rejected claims 59 and 64 under 35 U.S.C. §112, second paragraph, as being indefinite. The Examiner stated that “it is unclear if the columns [of the tables] are designated as having an ‘and’ operator or an ‘or’ operator.”

In response, claims 59 and 64 have been amended to recite MOCVD conditions that include:

“...Correlative Materials or Processing Requirements, to yield a ferroelectric PZT film having PZT Properties of ferroelectric polarization, leakage current density, dielectric relaxation, retention, avoidance of cycling fatigue, e-field scalability, surface smoothness, and grain size, wherein said Correlative Materials or Processing Requirements and PZT Properties comprise:”

(see claim 59, lines 3-6, and claim 64, lines 2-5; emphasis added)

All of the listed “Correlative materials or Processing Requirements” are required in order to produce the claimed PZT film with PZT Properties of ferroelectric polarization, leakage current density, dielectric relaxation, retention, avoidance of cycling fatigue, e-field scalability, surface smoothness, and grain size.

Furthermore, claims 59 and 64 have been amended to include semicolons after each claim limitation in the Correlative Materials or Processing Requirements column. Additionally, the operator “and” has been included after the second to last claim limitation in the Correlative Materials or Processing Requirements column.

Accordingly, the columns of the tables of claims 59 and 64, as amended herein, are designated as having an “and” operator.

Claims 59, 62 and 64 as amended herein are now in fully proper form, and comply with the requirements of 35 USC §112. Withdrawal of the rejection of such claims therefore is requested.

Rejection of Claims 38-60 and 62-64 and Transversal Thereof

In the December 1, 2003 Office Action, the Examiner rejected claims 38-60 and 62-64¹ on cited reference grounds, including rejections of:

claims 38-42, 50, 51, 53-55, 57-60, and 62-63 under 35 U.S.C. §103(a) as being unpatentable over Satoh et al. U.S. Patent No. 5,757,061 (hereinafter “Satoh”) in view of Roeder et al. (TI, Defense Systems & Electronics Group) (hereinafter “Roeder”);

¹ It is noted that the Office Action Summary incorrectly identified the claims that were rejected. The Office Action Summary indicated claims 28-60 and 62-64 were rejected. Since claims 1-37 were previously cancelled in the application, the Office Action Summary should have indicated that claims 38-60 and 62-64 were rejected.

claims 43-49 under 35 U.S.C. §103(a) as being unpatentable over Satoh in view of Roeder and further in view of Baum et al. U.S. Patent No. 5,916,359 (hereinafter “Baum”);

claim 52 under 35 U.S.C. §103(a) as being unpatentable over Satoh in view of Roeder and further in view of Visokay et al. U.S. Patent No. 6,211,034 B1 (hereinafter “Visokay”);

claim 56 under 35 U.S.C. §103(a) as being unpatentable over Satoh in view of Roeder and further in view of Kim et al. U.S. Patent No. 6,229,166 B1 (hereinafter “Kim”);

claims 38-42, 50, 51, 53-55, 57-60, and 62-63 under 35 U.S.C. §103(a) as being unpatentable over Miki et al. U.S. Patent No. 6,309,894 B1 (hereinafter “Miki”) in view of Roeder;

claims 43-49 under 35 U.S.C. §103(a) as being unpatentable over Miki in view of Roeder and further in view of Baum;

claim 52 under 35 U.S.C. §103(a) as being unpatentable over Miki in view of Roeder and further in view of Visokay; and

claim 56 under 35 U.S.C. §103(a) as being unpatentable over Miki in view of Roeder and further in view of Kim.

Such rejections are traversed in application to claims 38-60, 62 and 64 as amended herein. Reconsideration of the patentability of such amended claims is requested, in light of the ensuing remarks.

Patentability of Claims 38-60, 62 and 64

Applicants’ claims have been amended herein to recite the method of the invention as involving determining liquid delivery MOCVD conditions by plateau effect determination, and conducting liquid

delivery MOCVD under such conditions.

Claim 38, for example, recites

38. (Currently amended) A method of fabricating a ferroelectric PZT film on a substrate, comprising selecting MOCVD conditions for producing a ferroelectric PZT material, and forming the film by liquid delivery MOCVD on the substrate under said MOCVD conditions for producing a said ferroelectric PZT material, wherein said selecting MOCVD conditions comprises:

establishing a correlative empirical matrix of plots of each of ferroelectric polarization, leakage current density, and atomic percent lead in PZT films, as a function of each of temperature, pressure and liquid precursor solution A/B ratio, wherein A/B ratio is the ratio of Pb to (Zr + Ti);

identifying from said plots an inflection point of each plot as defining a region of operation with respect to independent process variables of temperature, pressure and liquid precursor solution A/B ratio; and

conducting the liquid delivery MOCVD at temperature, pressure and liquid precursor solution A/B ratio values selected from said region of operation.

(Claim 1, as amended),

consistent with the disclosure at page 6, lines 13-20 defining “plateau effect determination” as

“...establishing a correlative empirical matrix of plots of each of ferroelectric polarization, leakage current density and atomic percent lead in PZT films, as a function of each of temperature, pressure and liquid precursor solution A/B ratio, wherein A/B ratio is the ratio of Pb to (Zr + Ti), and identifying from the plots the ‘knee’ or inflection point of each plot as defining a region of operation with respect to the independent process variables of temperature, pressure and liquid precursor solution A/B ratio, and conducting the MOCVD process at a corresponding value of the temperature, pressure and liquid precursor solution A/B ratio selected from such region of operation...” (specification, page 6, lines 13-20, emphasis added).

Independent claims 56 and 60 have been amended correspondingly to claim 38. Independent claims 57, 58, 59, 64 and newly added independent claim 69 contain recital of plateau effect determination for the MOCVD conditions that are employed in the recited deposition of material on a substrate.

By their dependence under claim 38 or claim 60, claims 39-55, 62 and 64-68 also require such plateau effect determination.

Thus, all pending claims 38-60, 62 and 64-69 as amended or newly added herein require the MOCVD conditions to be determined by plateau effect determination, which as discussed hereinabove is defined in the instant application at page 6, lines 13-20 thereof as

“...establishing a correlative empirical matrix of plots of each of ferroelectric polarization, leakage current density and atomic percent lead in PZT films, as a function of each of temperature, pressure and liquid precursor solution A/B ratio, wherein A/B ratio is the ratio of Pb to (Zr + Ti), and identifying from the plots the ‘knee’ or inflection point of each plot as defining a region of operation with respect to the independent process variables of temperature, pressure and liquid precursor solution A/B ratio, and conducting the MOCVD process at a corresponding value of the temperature, pressure and liquid precursor solution A/B ratio selected from such region of operation...” (specification, page 6, lines 13-20, emphasis added).

Thus, “plateau effect determination” requires establishing an empirical matrix of plots of each of

- (1) ferroelectric polarization (P_{sw});
 - (2) leakage current density; and
 - (3) atomic percent lead in PZT films
- as a function of three variables:
- (4) temperature;
 - (5) pressure; and
 - (6) liquid precursor solution A/B ratio.

FIG. 2 of the instant application (reproduced below and annotated for ease of understanding) shows an example of the above-mentioned matrix of plots.

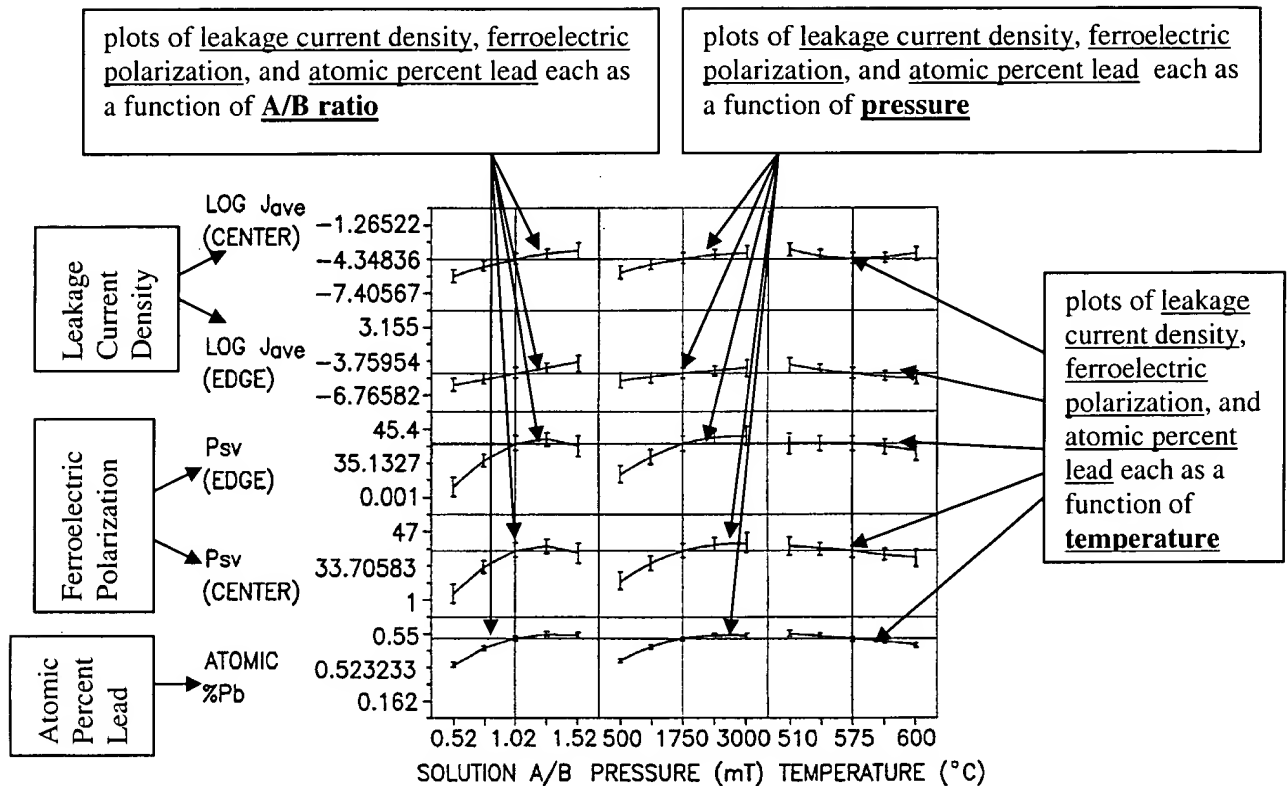


FIG.2

None of the cited references teaches the determination of MOCVD conditions by plateau effect determination.

There is accordingly no derivative basis in the cited references for the applicants' claimed invention.

In the December 1, 2003 Office Action, the Examiner asserted that "Roeder teaches plateau effect determination (page 3, last paragraph, to page 6) in order to optimize that [sic] properties and deposition of the PZT material" (see Office Action, page 3, lines 20-21 to page 4, line 1; also see Office Action, page

6, lines 11-13).

This assertion is incorrect – it confuses remanent polarization discussed in Roeder with ferroelectric polarization. Remanent polarization and ferroelectric polarization are entirely different and non-analogous phenomena.

Roeder does not in any way disclose ferroelectric polarization (P_{sw}) as a function of A/B ratio, much less describe any approach that involves plotting P_{sw} as a function of A/B ratio as a methodology in order to determine suitable conditions for carrying out MOCVD in order to deposit ferroelectric films on a substrate.

Roeder only discloses a relationship of remanent polarization as a function of A/B ratio for PZT films (see Roeder, FIG. 7 and page 4, last paragraph).

Remanent polarization, however, is not equivalent to or suggestive of **ferroelectric** polarization.

The Examiner's attention is directed to page 5, line 3 of the present application, where **remanent polarization** (P_r) is defined as

“the polarization at zero volts after passing through V_{op} ”².

In contrast, at page 5, lines 5-9 of the present application, **ferroelectric polarization** (P_{sw}) is defined as

“ $P_{sw}=P^*-P^\wedge$, wherein P^* is the polarization transferred out of the capacitor traversing from zero to V_{op} volts when the capacitor starts at $P_r(-V_{op})$, and P^\wedge is the polarization transferred out of the capacitor traversing from zero to V_{op} volts when the capacitor starts at $P_r(V_{op})$ ”.

² V_{op} is the operating voltage, as identified at page 5, line 16 of the originally filled application.

As is apparent from the foregoing, remanent polarization is not equivalent to or suggestive of ferroelectric polarization.

Roeder discloses only remanent polarization, P_r , as a function of A/B ratio.

Roeder does not in any way disclose, suggest or speculate about any relationship between ferroelectric polarization, P_{sw} , and A/B ratio.

Roeder therefore provides no derivative basis for plotting **ferroelectric polarization** as a function of liquid precursor solution **A/B ratio** as part of a determinative methodology involving

establishing a correlative empirical matrix of plots of each of ferroelectric polarization, leakage current density, and atomic percent lead in PZT films, as a function of each of temperature, pressure and liquid precursor solution A/B ratio, wherein A/B ratio is the ratio of Pb to (Zr + Ti);

identifying from said plots an inflection point of each plot as defining a region of operation with respect to independent process variables of temperature, pressure and liquid precursor solution A/B ratio; and

conducting the liquid delivery MOCVD at temperature, pressure and liquid precursor solution A/B ratio values selected from said region of operation

as recited in amended claim 38 and required by claims dependent thereunder, or as otherwise involving “plateau effect determination” as required by applicants’ other claims rejected on reference grounds including Roeder.

No other cited references remedy such deficiency of Roeder, in relation to applicants’ claimed invention.

Corresponding deficiencies to those discussed above (relating to the absence of any basis in Roeder for determining the relationship between ferroelectric polarization, P_{sw} , and A/B ratio) exist in the cited references for pressure and temperature relationships, as utilized in the method of the applicants' claimed invention for determining MOCVD process conditions for forming a ferroelectric PZT film.

The plateau effect determination specified by applicants' claims requires pressure as a variable in the empirical matrix of plots. In this matrix of plots, each of ferroelectric polarization, leakage current density and atomic percent of lead is plotted as a function of pressure. See, for example, claim 38, which recites, *inter alia*,

“establishing a correlative empirical matrix of plots of each of ferroelectric polarization, leakage current density, and atomic percent lead in PZT films, as a function of each of temperature, pressure and liquid precursor solution A/B ratio, wherein A/B ratio is the ratio of Pb to (Zr + Ti);

identifying from said plots an inflection point of each plot as defining a region of operation with respect to independent process variables of temperature, pressure and liquid precursor solution A/B ratio; and

conducting the liquid delivery MOCVD at temperature, pressure and liquid precursor solution A/B ratio values selected from said region of operation”

(emphasis added)

as constituent steps of applicants' claimed method.

None of the cited references teaches plotting ferroelectric polarization, leakage current density and atomic percent lead as a function of pressure, or of otherwise carrying out the steps of applicants' claimed invention to form a ferroelectric PZT film on a substrate.

In like manner, the plateau effect determination specified by applicants' claims requires temperature as a variable in the empirical matrix of plots. In this matrix of plots, each of ferroelectric polarization, leakage current density and atomic percent of lead is plotted as a function of temperature. See, for example, claim 38, which recites, *inter alia*,

“establishing a correlative empirical matrix of plots of each of ferroelectric polarization, leakage current density, and atomic percent lead in PZT films, as a function of each of temperature, pressure and liquid precursor solution A/B ratio, wherein A/B ratio is the ratio of Pb to (Zr + Ti);

identifying from said plots an inflection point of each plot as defining a region of operation with respect to independent process variables of temperature, pressure and liquid precursor solution A/B ratio; and

conducting the liquid delivery MOCVD at temperature, pressure and liquid precursor solution A/B ratio values selected from said region of operation”

(emphasis added)

as constituent steps of applicants' claimed method.

None of the cited references teaches plotting ferroelectric polarization, leakage current density and atomic percent lead as a function of temperature, or of otherwise carrying out the steps of applicants' claimed invention to form a ferroelectric PZT film on a substrate.

In this respect, the Examiner's attention is directed to the fact that Roeder **teaches away** from utilizing temperature in any manner that would point in the direction of applicant's plateau effect determination methodology. See Roeder at page 2, line 3 from bottom of the page, to page 3, line 2:

“Values [of dielectric constant] are shown in Figure 2 for films deposited at 550 and 590°C. The fact that

the values fall along the same line indicates that the films are qualitatively similar for both deposition temperatures. This behavior is consistent with the observation of similar crystalline diffracted intensity in XRD patterns for similar thickness films at either temperature.” (emphasis added).

Based on the foregoing, the absence of derivative basis in the cited references for applicants' claimed invention is clear.

None of the cited references teaches or in any way suggests

“establishing a correlative empirical matrix of plots of each of ferroelectric polarization, leakage current density, and atomic percent lead in PZT films, as a function of each of temperature, pressure and liquid precursor solution A/B ratio, wherein A/B ratio is the ratio of Pb to (Zr + Ti);

identifying from said plots an inflection point of each plot as defining a region of operation with respect to independent process variables of temperature, pressure and liquid precursor solution A/B ratio; and

conducting the liquid delivery MOCVD at temperature, pressure and liquid precursor solution A/B ratio values selected from said region of operation”

or otherwise teaches or suggests applicant's claimed plateau effect determination methodology as recited in claims 38-60, 62 and 64-69.

Such claims therefore are patentably distinguished over the art and as amended are now in form and condition for allowance.

The Examiner therefore is respectfully requested to responsively allow the pending claims 38-60, 62 and

64-69.

Fees Payable for Newly Added claims 65-69

With the newly added claims 65-69 and the cancellation of claim 63 herein, one additional independent claim and four additional total claims have been added, beyond the number for which payment previously has been submitted.

A credit card authorization form is enclosed herewith authorizing charging of the added claims fee in the amount of \$158.00 for added claims 65-69.

The U.S. Patent and Trademark Office hereby is authorized to charge any deficiency in fees, or to credit any excess payment, to Deposit Account No. 08-3284 of Intellectual Property/Technology Law.


CONCLUSION

In view of the amendments and foregoing remarks, it is respectfully submitted that all pending claims 38-60, 62 and 64-69 are in form and condition for allowance.

A Notice of Allowability therefore is requested.

In the event that any issues remain outstanding, the Examiner is requested to contact the undersigned attorney at (919) 419-9350 to discuss their resolution, so that this application may be passed to issue at an early date.

Respectfully submitted,



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